

Voyager Bulletin

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ENCOUNTER MINUS 58 DAYS — Voyager 1 took this picture of the planet Jupiter on January 6, the first in its three-month-long, close-up investigation of the largest planet. The spacecraft, flying toward a March 5 closest approach, was 57.6 million kilometers (35.8 million miles) from Jupiter and 598.2 million kilometers (371.7 million miles) from Earth. As the Voyager cameras begin their meteorological surveillance of Jupiter, they reveal a dynamic atmosphere with more convective structure than had previously been thought. While the smallest atmospheric features seen in this picture are still as large as 1,000 kilometers (600 miles) across, Voyager will be able to detect individual storm systems as small as 5 kilometers (3 miles) at closest approach. The Great Red Spot can be seen near the limb at the far right. Most of the other features are too small to be seen in terrestrial telescopes.

Summary

Voyager 1, 52.9 million kilometers (32.8 million miles) from Jupiter, has settled into its daily routine of imaging observations, system scans, infrared samplings, and playbacks. One-way light time is 33 minutes 18 seconds.

Voyager 2 is cruising quietly, with several routine calibrations scheduled for the next week. At 127.4 million kilometers (79.2 million miles) from Jupiter, one-way light time to Earth is 30 minutes 2 seconds.

The Voyager Spacecraft

(This is the twelfth in a planned series of brief explanatory notes on the spacecraft and its subsystems.)

Part 12 — Infrared Interferometer Spectrometer and Radiometer (IRIS)

Jupiter, with its colorful and distinctive bands of clouds, has puzzled man for many centuries. Why are the bands, known as zones (light) and belts (dark), so well-defined? What determines their colors? How deep is the cloud cover? What lies beneath it? Does Jupiter have a solid surface at all?

Voyager's experiment with the most tongue-twisting name, the infrared interferometer spectrometer and radiometer — usually known simply as IRIS — is designed to probe the atmosphere of the Giant Planet for answers to some of these questions. Jupiter's satellites and the Saturnian and Uranian systems will be explored as well.

Each distinct chemical compound has a unique spectrum. As a result, by measuring the infrared and visible radiation both given off (emitted) and reflected from an object, a great deal can be learned about atmospheric gas composition, abundances, clouds, hazes, temperatures, dynamics, and heat balance.

Scientific Objectives

Hydrogen, deuterium, helium, methane, ammonia, ethane, and acetylene have been identified in the Jovian atmosphere above the upper cloud deck. Deeper measurements (through holes in the clouds) indicate the presence of carbon monoxide, water, deuterated methane, germane and phosphene as well. Many of these constituents are also

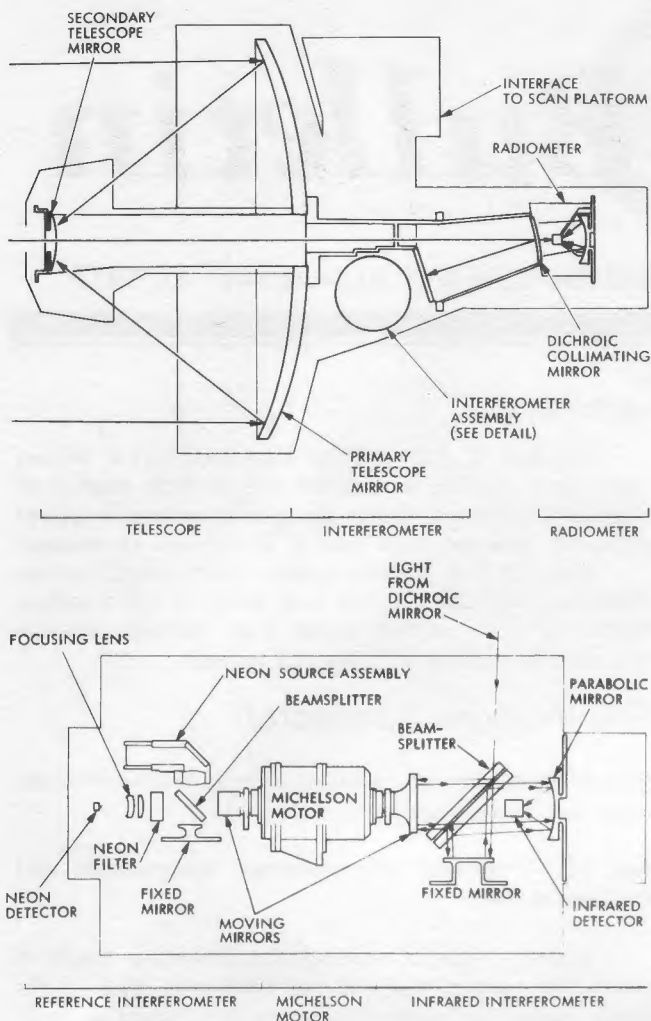
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The Voyager Spacecraft — IRIS (contd)

present on Saturn. Titan, one of the satellites of Saturn, is also known to have a substantial atmosphere. Voyager's IRIS will measure the atmospheric composition and structure on all of these bodies. Once the composition of an atmosphere is determined, knowledge of its absorption properties can be used to measure temperatures at various depths as a function of pressure. The clouds appear to form well-defined layers in the atmosphere, and above these are tenuous hazes. The ease with which these structures absorb or emit infrared radiation and light will permit a determination of cloud depth, as well as state (ice or aerosol).

Jupiter's banding has been observed for centuries. Why has it persisted for so long? Most theories explain the bands as the result of convection — circulation of warm and cool air. Jupiter appears to have an internal heat source, and a relation appears to exist between cloud color and temperature in both the zones and belts. Although Jupiter's banding runs east and west, considerable north-south motions of the atmosphere also exist and will be probed.

Many ices and minerals have distinctive spectral characteristics. Using these signatures, composition and temperature maps of the satellites will be constructed. Together with images also obtained by Voyager, these can be used to investigate the geology and evolution of these bodies. Comparisons among the satellites will be made; it is already known, for example, that the more dense Jovian satellites are closer to the planet, while the less dense are farther out. Such variations of satellite properties with distance from Jupiter may lead to further understanding of the formation of each, and possibly of the planet itself. Perhaps more than the large Galilean satellites, tiny Amalthea, closest to the parent planet, may pro-

vide insight into its own origin, since it is too small to have undergone extensive internal changes, such as the melting that has resulted in the earth's molten core.

Instrumentation

IRIS will measure the intensity and spectral distribution of infrared radiation reflected and emitted by atmospheres and surfaces. Light is gathered by a 50-centimeter (20-inch) diameter telescope and directed into the optics of the instrument. Within the optics assembly, the light strikes a mirror which reflects wavelengths longer than 2.5 microns into the interferometer and transmits those shorter than 2.0 microns into the radiometer. This mirror is called a dichroic collimator; that is, it separates the lightwave into various wavelengths (colors) and reflects these as parallel rays.

The radiometer responds to solar radiation in the spectral range from 0.3 to 2 microns; that is, from the ultraviolet through the visible spectrum and into the near infrared.

The interferometer assembly actually contains two interferometers: a reference instrument having an internal source of neon light, and the infrared instrument itself, which responds to radiation in the range of 2.5 to 50 microns (the mid- to far infrared).

The infrared light reflected into the interferometer assembly by the dichroic collimator is further split into two beams; one of these is focussed on a fixed mirror, while the other is focussed on a moving mirror. The beams are reflected from these mirrors and recombined so that they interfere with each other, and the resulting intensity is measured. If the moving mirror is in a position so that the recombined beams are out of step, then this intensity is zero; if the mirror position is such that the recombined beams are in step, then the intensity is large. The variations of this intensity as the position of the moving mirror changes represent the interferogram, which is the output of the instrument.

To help prepare the interferogram for radio transmission, the reference interferometer is used. One mirror in this interferometer moves with the moving mirror of the infrared interferometer. In the same way that the infrared radiation is handled in the infrared interferometer, the light from a single red neon line is passed through the reference interferometer to provide a regularly varying (sinusoidal) signal; the instants at which this crosses zero are used to control the motion of the mirrors and to determine when the light intensity in the infrared interferometer is measured. The resulting series of pulses is sent to Earth, where it is processed by computer to provide the infrared spectrum.

Mounted on the scan platform, the IRIS assembly weighs about 18 kilograms (40 pounds), including the telescope, radiometer, interferometers, electronics, and power supply. It uses about 14 watts of power of which 8 watts are used for temperature control. The instrument was designed and fabricated by Texas Instruments, Inc., Dallas, Texas.

Investigators

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